THE TELEGRAPHIC JOURNAL.
VOL IV.—No. 79.

## SUBMARINE TELEGRAPHS.

LAST month the land lines were suffering from severe attacks made on their stability by wind and snow. It appears now to be the turn of the submarine system to suffer. The Eastern Extension line is again broken between Penang and Madras and between Java and Australia. The Western and Brazilian system has just been interrupted for some weeks between Chuy and Montevideo. The Pernambuco and Para section and the Para and Pernambuco lines are described in the report of the West India and Panama Company as having been intermittent in their working, and lastly we have had a total interruption in the Anglo-American system, by the break down of the French Atlantic and of the short cables from Placentia Bay to St. Pierre and Cape Breton. The re-establishment of communication was announced on the 8th, and again on the 10th.

It is an ill wind that blows nobody good, and the Direct United States Company, after all their misfortunes, must, for a short time, have been reaping a little harvest. In fact, the traffic, which had been for some time divided between the our cables of the Anglo-American and the Direct Cable, and, since the interruption of the French Atlantic, between three Anglo-American cables and the single Direct, was suddenly thrust on to the single Direct cable only. Naturally there was delay—thus proving that the traffic of the Anglo-American Company cannot be carried on by a single cable, although promoters of new lines have continually stated that it could. Duplex would here have been of considerable use. Mr. Stearns, we believe, has been experimenting for some time on the Anglo-American cables, but with what success we know not. Certainly a company with a single cable ought to make strenuous efforts towards the working of duplex, which, in cables of the length of the Atlantic, has not as yet been successfully accomplished, although shorter submarines have been so worked.

The Direct Company have now to compete, until the French Atlantic is repaired, with three cables; so that, according to the law of Atlantic telegraph traffic, which divides itself directly between equal channels of communication, the Direct Company should get one-fourth of the total receipts; could they work duplex they would get two-fifths.

This is, at least, the second time within a few years that the Anglo-American system has been entirely interrupted through the failure of the lines on the other side of the Atlantic. Their shallow-water cables, which were never very substantially proportioned, are beginning to wear out, and will have to be increased in number and size.

It does not seem improbable that the time is coming when, if the Anglo-American wish to preserve their realm, they will have to employ more than one repairing ship. The 1865 cable broken in two places, the French Atlantic broken in one, and the cables on the other side in such a tottering state that a repairing ship has to be constantly patching them up, is not a lively look out for a single repairing ship, even if another cable does not soon give out. The 1865 cable failed in March '73, and the company has only made one feeble and costly attempt to repair it, and it is evident that, if their repairing ship could not find time during two years to repair these two faults, with the French Atlantic broken, and the permanent invalids on the other side to attend to, there will be no better chance this summer.

The Eastern Extension Company are beginning to learn also that cables have to be maintained and repaired, having two break-downs in their systems. Indeed, the General Managers, who came in on the top of the flood of success of submarine telegraphs, and who have had as yet only the youth of their cables to deal with, must be beginning to find that their old age is rather troublesome to manage. It is questionable whether the experience gained at each repair is now made as much use of as when engineers were more to the front, and it seems possible that shareholders may find it necessary to go back a little to engineers to remedy a state of affairs which, if it continues, may leave us with scarcely any submarine communications at all.

## ELECTRICAL MEASUREMENT OF VERY SMALL INTERVALS OF TIME.*

By ROBERT SABINE.

WHEN a charged body, accumulator, or cable, is discharged steadily, the rate at which its electricity is neutralised is a definite one, depending upon the resistance of the circuit through which the discharge takes place. If, during the first second, a certain per centage of the original charge is neutralised, then during the next second the same per centage of the remainder will be neutralised, and so on, until the whole of the charge is reduced to zero. This behaviour is very clearly explained by Dr. Lardner in his manual of electricity†, in the chapter on the dissipation of electricity and imperfect insulation.

* Communicated by the Author.
† Manual of Electricity, Magnetism, &c., by D. Lardner, 1841, vol. I, pp. 284 to 307.

Applied to cable-work, we make use of this law of the fall of charge to find the insulation resistance, when we know the electrostatic capacity of a cable, by allowing the original charge to leak away during one or more minutes.

If the original charge give an excursion of the light point of a mirror galvanometer of C divisions, and, after the cable has remained insulated for $t$ seconds, we find on discharging it the light point move through $c$ divisions we calculate the insulation resistance, R, by the formula—

$$R = \frac{t}{f \log. \frac{C}{c}}$$

$t$ being the interval of insulation, in seconds, and $f$ the electrostatic capacity. When $f$ is expressed in microfarads, R is given in megohms; but when $f$ is in farads, R is in ohms. This formula, in its freedom from numerical constants, shows the advantage of the absolute system of units over the arbitrary ones.

It occurred to me some years ago, that by knowing the values of R and $f$ of an accumulator very exactly, this law of fall of charge might with advantage be used for determining very small intervals of time. The dielectric resistance of an accumulator was, I found, too great, and varied too much with temperature to be inserted in the formula, and it was therefore necessary to make the insulation so good that its resistance (R) could practically be called infinite. Then by connecting the two sides of the charged accumulator, during the unknown interval, $t$ seconds, with a wire resistance $r$, this interval would be expressed by

$$t = f r \log. \frac{C}{c} \text{ . . . seconds.}$$

In carrying out a series of experiments, the accumulator which I use is insulated with mica plates and shell-lac: its internal resistance is over 250,000 megohms, whilst with a discharging resistance of 0.1 megohm, I find it practicable to determine time intervals of about $\frac{1}{1000}$ of a second.

The system may be arranged either (1) so that the accumulator is partially discharged during the interval of time which a contact lasts, or (2) by interrupting in succession the battery and then the discharging resistance wire.

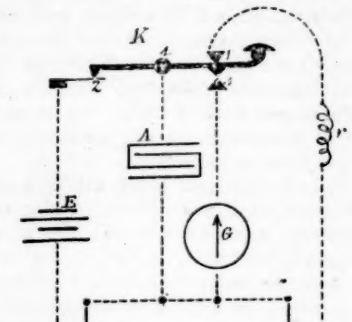
As an illustration of the first mode, an anvil, well insulated, was connected with one side of the charged accumulator, whilst a light hammer was connected with the other side of it, through the wire resistance $r$. When the hammer was struck sharply on the anvil the charge of the accumulator leaked, during the short time the blow lasted, through $r$, and the remainder of electricity was then discharged through the galvanometer.

The capacity ($f$) of the accumulator was 0·333 $^{m}/_{f}$, the resistance ($r$) was 1,000 ohms. The instantaneous discharge (C), with a single cell, was 306 divisions, and the discharge ($c$), after a single blow had been struck with the hammer upon the anvil, was only 262 divisions. Therefore the electrical duration of the blow will have been—

$$t = 0{\cdot}333 \times 0.0001 \times \log \frac{306}{262} = 0{\cdot}000052 \text{ sec.}$$

By a series of observations with a constant period of discharge, it was found that altering the resistance $r$ did not affect the calculated result, and it may be concluded, therefore, that the resistance of the contact at the instant of the blow is inappreciable. A series of ten successive blows before finally discharging the accumulator gave the calculated time exactly ten times the mean duration of a single blow.

The second mode, that of the successive separation of the battery and leakage circuits, is rather more complicated. It is best illustrated by its use in determining the velocity of a pistol bullet. The two circuits which have to be broken are $a$ and $b$; first $a$, then $b$. They represent two thin wires




stretched at different distances from the muzzle of a pistol B. The battery E has so little resistance in comparison with the wire $r$, that whilst it charges the accumulator, its current flows through $r$ without the potential of the accumulator being affected perceptibly. The key K, pivotted at 4, is arranged with an upper front contact 1, and a back spring contact 2, so that when depressed the contact 1 is interrupted an instant before 2; and both are interrupted before 3 is closed.

The instantaneous discharge (C) is taken by simply depressing the key. Then the key having resumed its position of rest so as to recharge the accumulator, the wires $a$ and $b$ are successively interrupted by firing a shot through them. The interruption of $a$ puts the battery out of action, and the charge which is in the accumulator at the moment commences to flow out through the resistance $r$. This flow is stopped as soon as the shot reaches and breaks $b$. The observer, when he hears the report, depresses the key and reads the excursion ($c$) due to the remainder of the charge.

To ensure accuracy by this mode it is necessary, of course, that the resistance $r$ should be very great in comparison with that of the battery; and, furthermore, that the accumulator should be so well insulated that no perceptible

loss takes place through internal leakage, either during the interval of discharge or between the separation of the circuit of $r$ and the depression of the key. In practice these conditions are very easily secured.

A series of experiments was made with a small breech-loading pocket pistol, the bullet of which was fired through wires at different distances between 1 and 4 feet apart, the first wire being close to the muzzle. The resistance $r$ was 100,000 ohms; the accumulator 0·333 microfarad as before. The following are some of the results:—

| Range. $d$ | Excursion of light. C | Excursion of light. $c$ | Time of flight calculated. $t = fr \log \frac{C}{c}$ | Mean Velocity of Bullet. $\frac{d}{t}$ |
|---|---|---|---|---|
| | | | second. | feet per second |
| 1 ft. | 300 | 280 | 0·0023 | 436 |
| 2 „ | 300 | 259 | 0·0049 | 408 |
| 3 „ | 299 | 240 | 0·0074 | 408 |
| 4 „ | 299 | 230 | 0·0087 | 458 |

The differences of the mean velocities are probably due to inequalities in the charges of powder.

The method by which the results given by this system are checked with actual time, I have explained in the current (May) number of the Philosophical Magazine.

The system appears to give very concordant and trustworthy results; it is however, of course limited to isolated intervals which elapse between successive mechanical actions—the making and breaking of a contact, or the breaking of two contacts, and which cannot be repeated very quickly.

The advantage which it possesses over the systems with chronoscopes is that there is scarcely a limit to the minuteness of the interval which it is capable of appreciating. It is very generally assumed that the leakage formula is only strictly applicable in dealing with slow discharges through very high resistances. This is a mistake; the law is equally applicable for discharges through very small resistances; but the precaution must be observed not to allow the accumulator to be too empty when the discharge of the remainder is read, otherwise diselectrification current will affect the result. It is well also to arrange the resistance $r$ so that C and $c$ are not too nearly alike, because a small error of observation of either of them makes a greater proportional error in the difference of their logarithms. By arranging $r$ so that C is about twice or three times as great as $c$, no great error from these causes is to be feared.

The constant of the galvanometer, and the electromotive force of the battery are neither required to be known, but must not change during an observation. The only value required to be known are $r$ and $f$, both of which every practical electrician has ample command over.

A New Electric Battery.—M. Cerpaux proposes a battery made of a certain number of plates of copper and of zinc separated by a wooden lath. The plates are plunged in sand or moist earth, and an electric current is at once produced. If on the earth chloride of sodium be poured, a very intense current is generated.

## THE WORK-VALUE OF ELECTRO-MAGNETS ENCLOSED IN IRON.*

By CHARLES V. WALKER, F.R.S.

At the Conversazione held at Willis's Rooms by Mr. Latimer Clark, Past President of the Society of Telegraph Engineers, on the 21st December, 1875, one of the most notable exhibits was the collection, "No. 76, Altandæ Electro-magnets," by Mr. John Faulkner. In the circular distributed by Mr. Faulkner, they were described as "Faulkner's Altandi Systemæ. The Altandæ system depends upon a peculiar electric phenomenon, whereby one coil of an electro-magnet and of less size produces a greater amount of magnetism with less battery power than two coils on the old system."

The word Altandi or Altandæ was not inviting, but more magnetism with a lesser electro-magnet and from less electricity was very attractive.

Further reference was made to this system in the *Telegraph Journal* of 15th January, 1876, in a report of a lecture delivered before the Manchester Literary and Philosophical Society by Professor Osborne Reynolds, M.A., in which it was stated that "Mr. Faulkner has some magnets of this kind, which retain the keep with 100 times more force, when the outer tube is on, than when it is removed." In further confirmation of the value of magnets of this form, a letter from Mr. Ladd, of Beak Street, appeared in the *Telegraph Journal* of 15th February, 1876, the writer of which stated that he had constructed electro-magnets on this principle for the last twelve years. In the "Daboscy" form of electric lamp manufactured by Mr. Ladd, an electro-magnet is employed in connection with the clock-work, which regulates the carbon point. *The electro-magnet was enclosed in an iron tube connected at the base with the centre tube or bar:* and in this condition considerably greater power on the keeper was obtained than with the ordinary form.

The words in *italics* give the fundamental principle upon which this form of magnet is constructed. An ordinary electro-magnet becomes, in this way, a horse-shoe or U magnet, with the poles more than twice as near, and the armature practically one-half shorter than in the ordinary arrangement. The author failed to find any description or any mention made of electro-magnets of this description in the text books at his command, but quotes, on the other hand, the following from Count du Moncel's well-known book on the construction of electro-magnets:—"A bar of iron surrounded by a voltaic helix is strongly magnetised; whilst a cylinder of iron surrounding this same helix is not magnetised at all."

The author having on the South Eastern Railway over fourteen hundred electro-magnets, of the horse-shoe, or U form, under his charge, proceeded to inquire into the condition of a system which held out such fair prospects—not merely the cost, but the bulk and weight of the apparatus as well—promising to be reduced.

The experiments were conducted on one of the bells in ordinary use in the locomotives and in the guards' vans.

The bobbins are each $3\frac{1}{16}$ in. long by $3\frac{1}{8}$ in.

* Read before the Society of Telegraph Engineers, April, 1876.

diameter, and are wound each with 308 ft. of No. 18 copper wire, which weighs 35 ounces. The iron cores, connected at the back in the usual way by an iron bar, are $\frac{5}{8}$ of an inch in diameter, and each weighs $3\frac{1}{2}$ ounces. The distance from core to core is $2\frac{1}{2}$ inches; but the poles, by means of face-plates, are brought to within $1\frac{3}{10}$ inches of each other. The armature is $3\frac{1}{2}$ in. long by $\frac{1}{2}$ in. in width and thickness. The battery employed in the experiments was platinized graphite and zinc, the plates being 6 in. by 2 in., immersed in a solution of one part sulphuric acid to eight of water.

The results arrived at after a series of exhaustive experiments were:—

That a single coil, cased in iron, gave as much work-value as a pair of coils, each fitted up in the usual way, whilst a single encased coil with a "segment-armature" of special design gives about four and a half times as much work-value as an ordinary pair of coils.

A single encased coil is of no practical value, side by side with a cased coil; the former holds only ·5 of an ounce, while the carrying power of the latter, according to the armature used, varies from 3·39 ounces up to 17·80 ounces. Thus the best form of cased coil tried gave no less than thirty-five and a half times as much work-value as a plain coil.

## ON VOLTAIC ELECTRICITY.

By PROFESSOR TYNDALL, D.C.L., LL.D., F.R.S.*

### LECTURE I.

IN 1779 Viscount Mahon published his "Principles of Electricity." On the title-page he remarks—"This treatise comprehends an explanation of an electrical *returning stroke*, by which fatal effects may be produced even at a vast distance from the place where the lightning falls." This discovery is the starting-point of the present course of lectures.

Lord Mahon placed himself upon an insulating stool, so as to have his right arm 20 inches from the prime conductor of an electrical machine, and another person, likewise standing on an insulating stool, brought his right hand within a quarter of an inch of his left hand. When the conductor began to receive its charge, electricity passed between their hands in small sparks, the electrical fluid running from Lord Mahon's hand to that of his companion. When the prime conductor was discharged into the earth, the electricity which had departed by small degrees returned back to him in a sharp spark at the very same instant. When the other person stood on the floor the "returning stroke" was *still stronger*. He says: "The reason of it was this—the other person being no longer insulated, transmitted his superabundant electricity freely into the earth, I consequently became still more negative than before. Now when the returning stroke came to take place, not only the electricity which had passed from my body into the body of the other person, but also the electricity which had passed from my body into the earth (through him) did suddenly return upon me from his hand to my hand. This caused the returning stroke to be stronger than before. (Prof. Tyndall performed these experiments, and also exploded gunpowder by the return spark.)

These experiments explain the memorable observation made in the laboratory of Professor Galvani, of Bologna, 1780. On a table lay a skinned frog, insulated from the earth.

At some distance from the table stood an electrical machine, from the prime conductor of which a person took sparks. Whilst this was going on, another person accidentally touched the skinned frog with the point of a knife. It was then noticed that on the appearance of every spark the frog's limbs were convulsed. To produce the convulsions it was necessary that the frog should be united by a conductor with the earth. When, for example, the knife touching the frog was held by its insulating handle, instead of by its blade, the convulsions did not appear. The experiment is similar to that of Lord Mahon, when his assistant stood upon the earth. In Galvani's observation, the insulated frog had its electricities separated by induction, the positive being driven to the distant part of the frog, and the negative drawn to the front nearest the conductor. But, on taking the spark under these circumstances, though the separated electricities re-united, they were too small in quantity to produce any sensible effect. When, however, the frog was placed in connection with the earth, the repelled positive electricity could freely escape; a greater inductive charge, as explained by Lord Mahon, was thus rendered possible. The whole frog became negatively charged, and the returning stroke rose to a sufficient strength to convulse the dead limbs. On the lecture table the frog's legs kicked at a distance of several yards from the machine.

Galvani saw this effect with astonishment. It was not the stirring of the dead limbs which produced surprise, because it was already known that electricity possessed power of this kind. Kircher (1667) records that an electric fish in the midst of a number of dead fishes produced sympathetic quivering by its shocks. Caldani (1756) described what he called the "revival" of frogs by electricity. Galvani himself had experimented on frogs as early as 1773. But in the experiment above described no discharge whatever had passed through the frog. It lay at a considerable distance from the electrical machine. On reflection, Galvani concluded that the principle of life itself was brought within his grasp.

By his first observation, Galvani was led to a second one of a totally different description. He exposed frogs' limbs to the action of atmospheric electricity, by hanging them upon the railing of his garden. During the passage of a thunder storm he noticed convulsions which were doubtless due to the returning stroke. But he wished to examine the effect of atmospheric electricity without thunder. After long and fruitless waiting, he re-arranged his frog, and in doing so bent back the hook from which it was suspended until the frog touched both hook and railing. Though these were both, in the first place, of iron, convulsions ensued. He afterwards found a copper hook much more effectual than an iron one. On the evening of September 20th, 1786, this observation was made. It was entirely new. No known source of electricity had anything to do with it: the electric

* Report of a Course delivered at the Royal Institution, April to June, 1876.

machine, the thunder storm, and the ordinary electricity of the atmosphere were excluded. Galvani concluded that the animal body itself was a reservoir of electricity, the nerves and muscles constituting a kind of Leyden jar—the former charged with positive the latter with negative electricity. The discharges of this apparatus produced the phenomena to which we give the name of *life*.

Volta, of Pavia, was a master in the art of experiment long prior to the discovery of Galvani. He brought his great and accurate knowledge of electrical phenomena to bear upon that discovery. He tried to obtain strict quantitative notions regarding the sensitiveness of the frogs' limbs by determining how much electricity sufficed to convulse them. He found the amount astonishingly small. He noticed the augmentation of the effect produced by dissimilar metals, and employing, instead of a dead frog, his own tongue—tinfoil and a silver spoon being the two metals—noticed a peculiar taste was produced when the metals touched.

(This experiment had been made and described by Sulzer forty years previously, but the observation remained isolated.)

In 1792 Volta decided that Galvani's results were due to electricity, developed by the contact of dissimilar metals. Further experiments revealed to him the extraordinarily small differences in the state of metallic surfaces which sufficed to make a single metal behave like two metals. If one end of the same strip of metal were tarnished and the other bright, one end rough and the other smooth, one end hot and the other cold, contractions were produced on touching the frog with the two ends. The first observation of Galvani with the iron hook and the iron railing thus received its explanation.

Galvani had likened the combination of nerves and muscles to a Leyden jar, Volta obtained the convulsions by touching different parts of the same muscle.

In 1800, Volta announced the discovery, which was to make his name immortal; in a letter to Sir Joseph Banks,* he says:—"I took some dozens of discs of copper, brass, zinc—or, better—of silver, one inch in diameter, more or less (coins, for instance), and an equal number of plates of tin, or, what is much better, of zinc. I prepared also a sufficient number of discs of cardboard, leather, or some other spongy matter capable of imbibing and retaining water, or, what is much better, brine. . . . I place on a table a disc of silver, and on it a disc of zinc, then one of the moist discs, then another plate of silver, followed by one of zinc, to which a moist disc succeeds. . . . I continue to form of these several stages a column as high as can sustain itself without falling." This was Volta's pile.

(In the lecture, a pile of half-crowns, plates of zinc, and discs of flannel were used.)

Another arrangement of the zinc and silver, the same in principle as the pile, was what Volta called the "crown of cups."

"Cups, bowls, or drinking-glasses, made of any substance except the metals, are placed in a row and half-filled with salt and water, and connected together so as to form a kind of chain, by means of metallic arcs, each possessing two arms, the one of copper or silver, the other of zinc. A series of thirty, forty, or sixty of these goblets linked together in this manner forms the new apparatus."

A year after the publication of Volta's letter, the chemical action of the current was observed by Carlisle, and studied subsequently by Nicholson and Carlisle jointly. The voltaic current was found to be freely transmitted through the usual conductors, but stopped by glass and other non-conductors. Contacts being made by a drop of water, Carlisle observed a disengagement of gas around the touching wire. On the 2nd of May, 1801, at the instance of Dr. Nicholson, a tube was filled with New River water, and stopped by corks, through which passed two wires with an interval of an inch and a half between them. The pile employed was "thirty-six half-crowns with the corresponding pieces of zinc and paste-board." The gas collected was hydrogen. They had been led to expect a decomposition of the water, but it was with no little surprise that they found "the hydrogen extricated at the one wire, while the oxygen fixed itself in connection with the other wire." By employing platinum wire, they obtained the gases separately.

(The decomposition of water by the "half-crown pile" was shown on the screen by means of the electric light.)

(To be Continued.)

* "Phil. Trans.," 1800.

## Notes.

THE *Journal Telegraphique* for April 25th contains a long and illustrated article on Sir W. Thomson's syphon recorder.

The Eastern Extension Australasia and China Telegraph Company (Limited) announce that their cable between Java and Australia is interrupted. Messages for Australia will be sent by post from Singapore on 1st May, from Java on 3rd May, or from Galle on 7th May.

The Direct Spanish Telegraph Company (Limited) notify that direct communication between England and Bilbao is now re-established by means of their cable.—*Daily News*, April 28th.

The Eastern Extension Company's Madras Penang Cable being interrupted, as well as their Java Australia Cable, telegrams for Australia, Tasmania, and New Zealand can only be sent by the Great Northern Company's line to catch the mails of 1st proximo from Singapore. The Eastern Telegraph Company will accept messages for Australia, to go by wire to Point de Galle and thence by post, up to the evening of 12th May.—*Daily News*, April 29th.

The cable between Chuy and Montevideo, belonging to the Montevideo Telegraph Company, and worked by the Western Brazilian Telegraph Company, was interrupted on the 9th of April. The Brazilian Submarine Company notify from time to time the departure of steamers from Rio Grande-do-

Sul for Montevideo. The cable in question has an india-rubber core, and was made and laid by Mr. Henley. It was laid on bad ground and severely injured, and last year was repaired and deviated from its original route, and handed over in perfect order to the Western Brazilian Telegraph Company.

The traffic receipts of the Western and Brazilian Telegraph Company (Limited) for April were £9,155, against £1,311, for the corresponding month of last year. The cable from Rio Grande-do-Sul to Montevideo has been interrupted since the 9th ult. They have now given notice that their cable between Rio Grande-do-Sul and Montevideo was repaired on the evening of the 9th instant, at six o'clock, and is working well. This restores direct communication with Montevideo and West Coast of South America.

The Anglo-American Telegraph Company (Limited) notify that telegraphic communication by their route was interrupted last evening, consequent upon the failure of the cables between Newfoundland and Cape Breton. There is no interruption of communication with Newfoundland. The accident to these inter-island cables has been caused, it is thought, by the grounding of a large iceberg in Placentia Bay. It is hoped that the interruption will be of short duration, as a steamer is already on her way to restore communication.—*Daily News*, May 5th.

We are informed by the Direct United States Cable Company that their traffic, owing to the interruption on the Anglo-American Company's lines, has been so great that considerable delay in the transmission of messages is unavoidable, the traffic previously passing over five cables being now diverted and confined to one. As an instance of the enormous traffic to be dealt with by the Direct Company, we are officially informed that 872 messages were received up to yesterday after the interruption was announced, of which 700 were received during 24 hours, the whole travelling over a cable of 2,500 miles. Up to four o'clock to-day also 400 messages had been received from London alone.—*Daily News*, May 6th.

The *Times* of the 8th announced the repair of the Anglo-American System.

The Eastern Telegraph Company's traffic receipts for the month of April amounted to £30,354, against £31,252 in the corresponding period of 1875.

The number of messages passing over the lines of the Cuba Submarine Telegraph Company (Limited), during the month of April, was 3,008, estimated to produce £2,700, against 2,243 messages, producing £2,217 in the corresponding month of last year. The traffic receipts for the month of February, estimated at £2,500, realized £2,525.

The traffic receipts of the West India and Panama Telegraph Company (Limited) amounted in February to £3,996, as compared with £3,246 in the corresponding period of 1875.

The traffic receipts of the Great Northern Telegraph Company for the month of April amounted to 405,946f., against 349,850f. last year; and the total receipts from the 1st January to 30th April were 1,355,550f., against 1,178,204f. last year.

The receipts of the Submarine Telegraph Company for the month of April amounted to £9,093 against £9,298 for the corresponding period of the preceding year; and those of the Direct Spanish Telegraph Company (Limited) amounted to £811, against £1,494 in the corresponding period of last year.

The average time occupied in the transmission of telegrams between Madrid and England, by the Direct Spanish Telegraph during April was 2 hours and 24 minutes, including transmission over Spanish land lines.

The report of the Submarine Cables Trust to the meeting on the 5th of May, shows that the revenue for the financial year ended 15th April, including the balance brought forward, amounted to £27,975 and the expenses to £1,372, leaving a balance of £26,602. Of this sum £21,021 has been applied in payment of the coupons due 15th October and 15th April, £2,480 has been transferred to the redemption fund for the purchase of certificates, and the balance of £3,101 carried forward. Since the formation of the Trust 704 certificates have been redeemed.

A petition to wind up the Oriental Telegram Agency (Limited) has been presented to the High Court of Justice.

The Chairman and Directors of the Telegraph Construction and Maintenance Company gave a banquet at Willis's Rooms, on the 10th instant, to celebrate the completion of telegraphic communication between Australia and New Zealand.

In Russia a violent storm interrupted all the telegraphic communication on the night of the 11th April between St. Petersburg and Berlin, Varsovii, and the line to Libau. Inundations and storms also stopped the service on the Amour line, first on the 9th of April, between Kaidalavo and Nertschinsk, and afterwards on the two lines terminating at Kazan on April 15; but, thanks to the activity evinced on this occasion by the Russian authorities, the lines were immediately repaired.—*Journal Telegraphique.*

The International Ocean Telegraph Company's cable steamer *Professor Morse*, in command of Capt. Thomas Stead, arrived at Havana on Tuesday, April 4.

The steamer proceeded on the following day to pick up and repair the second Havana cable (laid in 1869), the fault in which had been located about one mile from its landing at Nojimer (eight miles from Havana), in from sixty to eighty fathoms of water. The repairs were completed on the night of the 9th, and the cable restored to perfect working order.

A detailed report of the work of picking up and repairing has not yet come to hand; but the best information received indicates that after an unsuccessful effort to underrun the cable from the shore, it was grappled and raised, the fault found, cut out, and a new piece spliced in. At eleven o'clock on Sunday night of the 9th, and before closing the splice, President Orton sent a telegram from the break to Vice-President Green, announcing their success and that the last joint was about being closed. The insulation of the restored cable is as perfect as when it was first laid.

After completing these repairs the steamers spent two or three days in recovering the heavy shore end of the first cable (laid in 1867), the use of which has been abandoned for several years.—*Journal of the Telegraph.*

The Select Committee of the House of Commons appointed to consider the working of the telegraphs since their transfer to the Government sat again on May 5th, at the House of Commons, Dr. Lyon Playfair presiding.

Mr. Graves, divisional engineer of the north-western division, said the larger part of the expenditure was rigidly defined by strict authorities founded on the estimates, or by special authorities which had been obtained before the outlay was made. For anything exceptional he had only authority to expend £3, but he would go beyond that amount in the event of a large break down, and then obtain his authority. The line men were infinitely below the present requirements, and they had to be supplemented by non-established men, for whom a large sum was charged. Witness said he had, in conjunction with Mr. Priest, inquired into the question of cost, and had reported in favour of abolishing the office of divisional engineer and reduction of superintendents. He thought their sphere should be enlarged, their responsibility increased, that the London office should undertake more direct duties of control, so as to have a closer grasp of the entire system. They recommended various subsidiary reforms in the way of accounts, and also with regard to the electric force. As a n result of their recommendation, there would be a saving of £10,000 a year.

In answer to Mr. J. Holms, witness stated that the maximum carrying power of a line, say 200 miles long, with an automatic transmitter, and a good receiving instrument, was 200 commercial messages an hour, each message averaging 27 words.

On the 27th ultimo the Postal and Telegraph business was removed to the large and handsome new Post Office recently completed in St. Nicholas-square, Newcastle-on-Tyne.

As the telegraph instrument room in the new building is, perhaps, the most unique of its kind in the kingdom, a few descriptive particulars may be interesting to our readers.

The instrument room itself is 90 ft. by 40 ft., and the instrument tables are arranged longitudinally.

There are three double tables and one wall table, so placed that the gangways are most ample.

There are 97 instruments of the different kinds used by the Post Office Telegraph Department connected up in this room, and there are spaces on the tables for 49 additional instruments.

Twenty-four miles of guttapercha wire were used in connecting the instruments in the room.

The test box is 8 ft. high and 14 ft. long, and provides terminals for 200 line wires and 1,100 battery wires. Pneumatic lifts are used for conveying the messages from the public office to the instrument room, and from the instrument room to the delivery department in the basement of the building.

The work of transferring the wires and instruments to the new building has been carried out by Mr. A. W. Heaviside, district superintendent, under the direction of Mr. Walsh, divisional engineer of Postal Telegraphs.

At the annual meeting of the Royal Institution, on Monday, a piece of plate and a purse containing 300 guineas were presented to Prof. Tyndall as a testimonial of congratulation on his recent marriage.

During the siege of Paris experiments were tried to make use of the conductibility of the Seine in order to establish communications with the outer world in spite of the Prussian blockade. Paris, however, surrendered before the apparatus had been arranged on the Upper Seine. This scheme has not been totally abandoned, and M. Bourbouge, a *preparateur* of the Sorbonne, has tried to establish the telegraph without wire. According to M. Parville, the plan has succeeded at a small distance by expending a large quantity of electricity, not less than forty elements being required to work magnetic needle at a distance of a quarter of a a mile. The same experimenter is said

to collect spontaneous currents from the earth with large electrodes. The interest of these experiments is unquestionable.

The kingdom of Burmah is at last to have a journal. The king himself is to be the chief editor and proprietor, and the royal penman threatens with the penalty of death all his subjects who will not subscribe to his paper. The method is certainly novel in the way of "working up" a circulation.

The traffic receipts of the Indiarubber, Gutta-percha, and Telegraph Works Company from the opening of the whole line (Lima to Caldera) have been as follows, at 40d. per dollar:—Four weeks ending 23rd October, 1875, £2,278; ditto, 20th November, £2,434; ditto, 18th December, £2,423; ditto, 15th January, 1876, £2,438; and ditto, 12th February, £2,558.

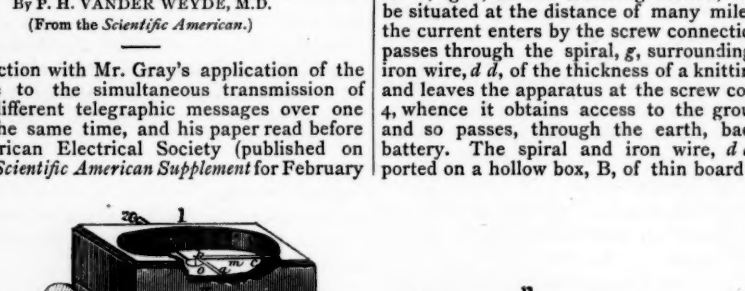
## THE INVENTION OF THE TELEPHONE.

By P. H. VANDER WEYDE, M.D.

(From the *Scientific American*.)

In connection with Mr. Gray's application of the telephone to the simultaneous transmission of several different telegraphic messages over one wire at the same time, and his paper read before the American Electrical Society (published on page 92, *Scientific American Supplement* for February 5), it may be interesting for the readers of this paper to obtain some information in regard to the invention of the telephone, by Reuss. As mentioned in the article above referred to, Page and Henry observed that, by rapid magnetization and demagnetization, iron could be put into vibrations isochronic with the interruptions of the current: and later, Marian experimented extensively in this direction, while Wertheim made a thorough investigation of the subject, which induced Reuss, of Friedrichsdorf, near Homburg, Germany, to apply this principle to the transmission of musical tones and melodies by telegraph: and he contrived an apparatus which we represent in the engravings.

The telephone of Reuss consists of two parts, the transmitting and receiving instrument. Fig. 1 represents the former, and is placed at the locality where the music is produced; fig. 2, the latter, is placed at the station where the music is to be heard, which may be at a distance of 100, 200, or more miles, in fact, as far as the battery used can carry the current: while the two instruments are connected with the battery and the telegraph wire in the usual manner. One pole of the battery is connected with the ground plate, the other with the screw, marked 2 in our fig. 1, and thence over a thin copper strip, *n*, with the platinum disc, *o*, attached to the centre of the membrane stretched in the large top opening of the hollow and empty box, K, intended to receive and strengthen the vibrations of the air, produced by singing before the funnel-shaped short tube attached to the opening in T. Over the ptatinum disc, *c*, attached to the elastic membrane, is a platinum point attached to the arms *b c* and *b* K, while a set screw brings this point in slight contact with the platinum disc mentioned. A part of the box is represented as broken and removed, in order to show the internal construction. The strip, *a b c*, is connected with the end, *s*, of the switch, *t s*, and the screw connection, 1, at the lower right hand corner, and also, through the telegraph wire, to the instrument, fig. 2, at the receiving station, which may be situated at the distance of many miles. Here the current enters by the screw connection, 3, and passes through the spiral, *g*, surrounding the soft iron wire, *d d*, of the thickness of a knitting needle, and leaves the apparatus at the screw connection, 4, whence it obtains access to the ground plate, and so passes, through the earth, back to the battery. The spiral and iron wire, *d d*, is supported on a hollow box, B, of thin board; while a cover D, of the same material is placed on top, all intended to strengthen the sound produced by the vibrations which the interruption of the current caused in the iron wire, *d d*, so as to make these vibrations more audible by giving a large vibratory surface, in the same way that the sounding-board of a pianoforte strengthens the vibrations of the air caused by the strings, and makes a very weak sound quite powerful.




PROFESSOR REUSS' TELEPHONE.

If a flute be played before the opening, T, or if a voice be singing there, the vibration of the air inside the box, K, causes the membrane, *m*, to vibrate synchronically, and this causes the platinum disc, *o*, to move up and down with corresponding frequency. At every downward motion the contact of this disc with the platinum point,

under *b*, is broken; and therefore the current is interrupted as rapidly as the vibrations occur. Let, for instance, the note C be sounded; this note makes sixty-four full vibrations in a second, and we have, therefore sixty-four interruptions of the electric current, which interruption will at once be transmitted through the telegraph line to the receiving instrument, and put the bar, *d d*, into exactly similar vibrations, making the very same tone, C, audible; and so on for all other rates of vibration. It is clear that, in this way, not only the rhythm of music can be transmitted (and this can be done by the ordinary telegraph), but the very tones, as well as the relative durations and the rests between them, can thus be sent, making a full and complete melody. The switch, *t s*, fig. 1, is intended, in connection with a similar one in fig. 2, to communicate between the stations, with the help of the electro-magnet, E E, to ascertain if station, fig. 2, is ready to receive the melodies: then it gives the signal, by manipulating the switch, which is received by the attractlon of the armature A, the latter arrangement being a simple Morse apparatus, attached to the telephone.

Professor Heisler, in his *Lehrbuch der technischen Physik* (3rd edition, Vienna, 1866), says, in regard to this instrument—"The telephone is still in its infancy; however, by the use of batteries of proper strength, it already transmits not only single musical tones, but even the most intricate melodies, sung at one end of the line to the other, situated at a great distance, and makes them perceptible there with all the desirable distinctness." After reading this account in 1868, I had two such telephones constructed, and exhibited them at the meeting of the Polytechnic Club of the American Institute. The original sounds were produced at the further extremity of the large building (the Cooper Institute), totally out of hearing of the Association, and the receiving instrument, standing on the table in the lecture room, produced (with a peculiar and rather nasal twang) the different tunes sung into the box, K at the other end of the line; not powerfully it is true, but very distinctly and correctly. In the succeeding summer I improved the form of the box, K, so as to produce a more powerful vibration of the membrane, by means of reflections effected by curving the sides; I also improved the receiving instrument by introducing several iron wires in the coil, so as to produce a stronger vibration. I submitted these, with some other improvements, to the meeting of the American Association for the Advancement of Science, and on that occasion (now seven years ago) expressed the opinion that the instrument contained the germ of a new method of working the electric telegraph, and would undoubtedly lead to further improvements in this branch of Science, needing only that a competent person give it his undivided attention, so as to develop out of it all that it is evidently capable of producing.

Before leaving this subject, I wish to draw special attention to the fact that the merits of this invention consists chiefly in the absence of musical instruments, tuning forks, or their equivalents, for producing the tones: any instrument will do, flute, violin, human voice, &c. If the aerial vibrations are only conducted into the box, fig. 1, the apparatus will send the pitch as well as the duration of the different tones, with the rests between, therefore not only transmitting perfect rhythm, but a complete melody, with its long and short notes. The two parts of the apparatus may even be connected each to a separate pianoforte; and if this were done in a proper manner, a melody played on the pianoforte connected with the transmitting instrument, fig. 1, would be heard in the pianoforte, at a great distance, connected with the receiving instrument, fig. 2.

# Proceedings of Societies.

## THE SOCIETY OF TELEGRAPH ENGINEERS.

(Continued from page 136.)

The conclusion arrived at by us 18 years ago of the absolute necessity of laying light cables and the folly of heavy cables seems now to have come true. Ten years ago, Mr. Longridge predicted that if a heavy cable, after being laid down, should happen to break, say in 2,000 fathoms of water, it would be impossible to get it up again. The present condition of the 1865 cable shows how far his statement was correct. The present type does not seem likely ever to succeed, for the hemp being gone, the iron after a time is oxidised, and in this condition is much heavier, and at the same time weaker, than it originally was. The cable can, doubtless, be lifted directly after it has been laid; but when the iron corrodes, the difficulty then arises. A $\frac{5}{8}$ths diameter cable might be made with the same conducting power; it could be laid successfully, and taken up with greater ease than those now in existence. The proper apparatus to pay out the cable is one which provides for a proportion of slack, not one which holds it in. To the '65 cable having been laid over some kind of valley, and hanging like the chain of a suspension bridge, its fracture was probably due. So long as the wire held good it was all right, and then, when it began to rust, the strain broke the cable. All these heavy wires around the cable should be abandoned. The type of cable, consisting only of copper, with, perhaps, some fine steel wires laid inside the gutta percha, and protected by some substance to keep it safe until it gets to the bottom, this laid with a due amount of slack, and not hanging over precipices, is the cable of the future.

Mr. W. Hooper agreed with Mr. Longridge as to the advisability of laying light cables. The iron outside the core in the present cables, deterrioating as it does, becomes after a time a burden more than an advantage to the cable. A good indestructible insulator with a covering to protect it, accomplishes all that is required. Marine insects do bore into guttapercha, yet Mr. Hooper stated that he could show a form of insulator which was not injured by these boring animalculæ.

Mr. F. C. Webb briefly explained the principles of a dynamometer designed by himself, illustrating it by a series of drawings.

Mr. R. Von Fischer Treuenfeld began by questioning Mr. Varley's statement as to the "porcupine" appearance presented by a cable in the act of submergence after passing over the drum, and

alleged that well manufactured cables raised after many months' submersion showed no signs of filaments, but looked as perfect as when in the manufacturer's tank. Without entering into the historical portion of the subject, already too fully discussed, he considered it advisable to point out that the first methods of testing wires electrically and determining faults were published by Dr. Werner Siemens, at the meeting of the "Academie de Science," on the 29th April, 1850. As regards Faraday's investigations with guttapercha, he rediscovered Siemens' laws of charges, but he afterwards acknowledged Dr. Siemens' claim to priority. Mr. Treuenfeld concluded his remarks by defending the opening statement in the paper that "the starting point of submarine telegraphy is to be found" in the Prussian lines of 1847-1852.

At the commencemeut of the evening a communication was read from Dr. Werner Siemens from Berlin, in reply to the various points started in the course of the discussion, and at the meeting held on the 22nd of March a further communication was read in reply to the discussion of the 8th of March, reported above. In these Dr. Siemens points out that if Faraday did not call attention to the electrical qualities of gutta percha until 1848, the priority of their discovery is at once proved, for insulated gutta percha wires were laid in the previous year, 1847, between Berlin and Grossberen. It is not, however, the first introduction of gutta percha as an insulating material which is claimed in the paper, but the construction of the first machine for manufacturing gutta percha *seamless* wires.

Newall succeeded, Dr. Siemens went on to say, in laying a heavy deep-sea cable only by following his, the writer's, theories, and taking his advice to have his vessel towed by an Italian frigate, and increase the power of the breaks.

Mr. Varley is correct in his remarks about the resistance offered by the rough hemp-covered surface of a cable: but they alter in no way the theories advanced in the paper, because the friction of a sliding body in liquids always causes the nearest layers of the liquid to move, whether the surface of the body be rough or smooth. Mr. Varley's claim of priority for a *loop* test is so far correct: he undoubtedly found out that method independently of others, and first published it in an accessible journal: at the same time the writer stated that the method was adopted by him for the localisation of faults in insulated gutta-percha wire coils as well as in double lines.

Referring to Mr. Longridge's criticism, Dr. Siemens stated that as the paper by Mesrs Longridge and Brooks was not published till 1858, it was consequently one year later than the demonstration and employment of his theory on the first successfully laid deep sea cable, namely, the Bona-Cagliari one. That theory was founded on the supposition of the falling cable taking a straight line, the sliding friction in the direction of the cable laying being simply proportional to the sliding velocity. The question at issue, with reference to the various problems connected with cable laying, centres itself on the law of the sliding friction in water. Practice has established empirical formulæ, which may be correct so far as they go.

Eytelwein theoretically based the quadratic law for the flow of liquids through tubes, on the assumption that with twice the velocity twice as much adhering water must be torn away from the sides of the tube with twice the rapidity, forgeting that the water on the sides of the vessel does not flow at all, but remains quiescent, while the velocity gradually increases towards the centre. Experiments conducted on a large scale by the writer, and published in the German *Telegraph Journal*, for 1866, show that in tubes of small diameter an outflow of water is obtained directly proportional to the difference of pressure. Wide tubes and high velocity seem to give a quadratic velocity factor simply, owing to the liquid vortices arising in the tubes. Newton says that the friction exerted by two strata of fluids moving in the same direction is proportional to the difference of their velocities. Numerous authorities are quoted by Dr. Siemens, who concluded his letter, and with it this interesting discussion, by asserting that he had not frivolously overthrown a commonly accepted principle and substituted another; but that he had, as far back as 1857, when his theory of cable laying was formed, convinced himself that the motion of a rope in water experiences a resistance directly proportional to the velocity.

## PHYSICAL SOCIETY.—29TH APRIL, 1876

PROFESSOR GLADSTONE, Vice-President, in the chair. The following gentlemen were elected members of the Society,—Professor F. Fuller, M.A., and Captain E. H. White.

The Secretary read a communication from Sir John Conroy, Bart., on a simple form of Heliostat. The defect of Fahrenheit's Heliostat, in which the beam of sunlight is reflected by a mirror moved by clock-work in a direction parallel to the axis of the earth, and then in the required direction by a fixed mirror, consists in the great loss of light. The author substitutes two silvered mirrors for the looking-glasses usually employed, and he has shown that the loss of light with this arrangement is less than when the light is once reflected from a looking-glass.

Mr. S. P. Thompson, B.A., B.Sc., then made a second communication on the so-called "Etheric Force," and described some experiments which he has recently made in the Physical Laboratory at South Kensington, on the subject. The name was given by Mr. Edison, the inventor of the Motograph, to the sparks obtained when a conductor is presented to the core of an electromagnet, the coils of which are traversed by an intermittent current. The results of the experiments conducted as originally described not proving satisfactory, various other arrangements were tried, and it was found that if the secondary current from an induction coil be used, instead of a current direct from the battery, the effects are much more marked. When the induced spark was thus diverted, either wholly or partially into a short coil which was insulated very perfectly from the core inside, a spark about $\frac{1}{4}$ inch in length, which has a decided effect on the nerves, could be drawn off from the core, and this was sufficient to illuminate a small vacuum tube; the spark, however, does not exhibit the usual signs of polarity. It was shown, by observing the illumination thus produced with a rotating mirror, that the

discharge is in reality a reciprocating one, each spark returning on its path after a minute interval of time. Under certain conditions, it is also possible to charge an electroscope either positively or negatively by means of the spark, and Mr. Thompson has shown that the spark ignites a jet of gas, but fails to deflagrate metallic wire or ignite gunpowder. From the above and other experiments, which will be exhibited on a future occasion, the author concludes that the cause of the phenomena is obvious, and that the hypothesis of a new force is unnecessary.

Professor Mc Leod referred to a paper on the same subject, which appeared in the *Chemical News* of the 28th of April, by Messrs. Houston and Thomson.

Mr. David Ross, B.A., inquired the tension of the Leyden jar arrangement used in the experiments, but Mr. Thompson pointed out that it would be very difficult of determination, on account of the rapid change of the spark from positive to negative.

## THE VICTORIA (PHILOSOPHICAL) INSTITUTE.

A MEETING of this Institute was held on Monday the 1st inst., at its rooms, 10, Adelphi-terrace. After the election of new members, of whom fifty were announced as having been admitted during the past four month, it was stated that Professor Birks would deliver the Annual Address for 1876, and that the next three meetings, by kind permission, were to be held at the house of the Society of Arts. A paper on "The Metaphysics of Scripture" was then read by Professor Challis, F.R.S., F.R.A.S., in which he took into account that department of metaphysics which comes after, and is intimately related to, natural science, his object being to inquire, in this limited sense, whether the basis of metaphysics could be said to exist in the teaching of Scripture Many took part in the discussion, after which Professor Challis replied, and the meeting terminated.

## ON THE PHENOMENA OF INDUCTION.

By M. MOUTON.

THE experiments which have been made and the theories formed in regard to induction-phenomena have generally referred to an induced wire included in a circuit; the electricity set in motion passed from one extremity to the other, either through the wire of a galvanometer or a magnetizing spiral, or through the air under the complex form of the spark. But we may ask, into what relative electric condition does the phenomenon of induction bring the two extremities of the wire of an induction-coil when no metallic communication is established between them, and when they are kept at too great a distance for the spark to clear it?

For the purpose of solving this problem, I made use of a Thomson's dial electrometer of large size; the needle was maintained charged by its communication with one of the poles of an open pile; and the two pairs of dials were, at a suitable time, connected with the ends of the wire by the intermedium of a condenser with a stratum of air. If, limiting ourselves to the case of the rupture of the inducing current, we suppose a commutator putting, at the same time that it produces that rupture, the ends of the induced wire in communication with the dials of the electrometer, the following is what will be observed.

If the duration of the communication, commencing with the breaking of the current, exceeds at a time which I have not tried to estimate rigorously, but which is not much less than ·001 of a second, the condenser does not become charged, and the needle of the electrometer remains at rest.

If the duration of this communication is reduced to much less than $\frac{1}{20000}$ of a second, we find charges absolutely different according to the instant at which this rapid contact is produced; and we can thus study, from less than $\frac{1}{10000}$ to $\frac{1}{20000}$ of a second, the difference of potential presented by the extremities of the induced wire.

The following is then the succession of the phenomena which I have observed:—

Take the times for abscissæ, the origin being at the metallic rupture of the inducing current, and the differences of potential (or, what comes to the same thing, the deflections of the needle) for ordinates.

At the time zero the difference of potential is *nil*; it then increases regularly, and at about $\frac{1}{10000}$ of a second reaches a maximum which can be kept to a remarkable degree constant; it afterwards decreases regularly, again becoming *nil*. But the phenomenon does not end there. If the examination be continued, the difference of potential changes sign, the positive extremity becomes negative, and *vice versâ*; there is a new maximum reached in the opposite direction, then a return to zero, then another change of sign, &c. I have counted in this way as many as 30 oscillations. The first oscillations have always seemed to me longer and more intense; they appear to tend rapidly towards isochronism. I beg, however, permission to reserve this question of the duration of the oscillations, which a special commutator, I hope, will soon enable me to determine.

In regard to the intensities, the results are very clear. I will give an instance:—

The inducing current being supplied by a single Daniell element with water and sulphate of copper, the inducing bobbin having only one thickness of wire, and the induced bobbin 10,000 turns of wire $\frac{1}{2}$ millim. in diameter, the first and second maxima reached a difference of potential equivalent to 80 Daniell elements, betrayed by a deflection of 350 divisions by the needle of the electrometer, which I was obliged purposely to render less sensitive. The 20th maximum reached 160 divisions.

The oscillatory phenomenon was first described by M. Blaserna; it was measured more carefully, but still only with respect to its duration, by M. Berstein,—both of these physicists sending the induced current for only a very brief period into a galvanometer.

I study the phenomenon in its entirety, from a purely static point of view without disturbing it; and I get a constancy and intensity of effect which permit me to trace, point by point, the curve which represents it.—*Comptes Rendus de l'Académie des Sciences*, vol. lxxxii. pp. 84–86.

## ON THE CHEMICAL ACTIONS PRODUCED BY THE DISCHARGES FROM AN INDUCTION-APPARATUS.

By M. BECQUEREL.

THE memoir commences by recalling the experiments of Wollaston on the decomposition of water by the electricity from the ordinary electrical machine, as well as those made by Faraday for the purpose of rendering sensible the decomposition of salts, when he sought solely to make evident the presence of acids and bases by aid of test-papers.

With a Ruhmkorff induction-apparatus, which gives a much more rapid succession of sparks than the ordinary electrical machine, more marked effects are obtained. The arrangement I have adopted to exhibit them is the following:—Taking a plate of guttapercha on which was placed a small slip of platinum in communication with the positive pole of the apparatus by means of a metallic stem, I applied to this slip of platinum a strip of paper moistened with a metallic solution (copper or silver), and then to the paper the point of a platinum wire connected with the negative pole. It was not long before the metal was seen depositing around the point in adherent layers. On a slip of platinum being placed between the paper and the point of this metal, it likewise became coated with a thin layer of metal. Submitting to experiment successively various solutions, the apparatus operating with only two chromic-acid couples, and sometimes with four, I thus obtained the reduction of copper, nickel, cobalt, iron, lead, bismuth, antimony, zinc, cadmium, silver, gold, and platinum.

I likewise applied myself to the formation of amalgams by aid of the same apparatus, following the method which Davy employed, with the pile, to obtain the amalgams of potassium, sodium, and other metals. On a slip of platinum which was brought into contact with the positive pole of the apparatus I placed a piece of caustic potass slightly moistened, and introduced into a small cavity in its surface a drop of mercury in contact with the point of a platinum wire or the negative pole of the induction-apparatus; after a few moments the globule changed into a pasty amalgam in which I perceived some crystals of this compound.

The copper amalgam was obtained by operating with a mixture of a solution of nitrate of copper and nitrate of mercury with which the band of paper applied on the platinum slip was moistened; in the same way were produced the amalgams of aluminium, magnesium and other metals. I conceive that the discharges of an induction-apparatus, when proceeding from electricity of high tension and taking place in rapid succession, are capable of producing powerful chemical effects.—*Comptes Rendus de l'Académie des Sciences*, vol. lxxxii. pp. 353, 354.

## CAOUTCHOUC.

JUST as the world was beginning to be told that the supply of this useful material was about to become short by reason of the destruction of the tree which produced it, and the thriftlessness which failed to keep up the supply by artificial cultivation, we are also informed of the fact that an entirely new source of supply has been discovered in Burmah, in a creeping plant, whose botanical name is *Chavannesia esculenta*, of the dogbane tribe; natural order, *Apocnaceæ*, Lindley. The plant is very common in Burmese forests, and is cultivated by the natives for the sake of its fruit, which is said to have an agreeable acid taste, and to mature at a season when tamarinds are scarce. Mr. G. W. Strettel, of Rangoon, has published an interesting descriptive notice on this plant. In 1860, in Mason's "Burma," it was described as yielding an excellent elastic gum, and believed to be *Echites macrophylla*, Wight. Another plant, *Anodendron paneculatum*, in Pegu produces rubber, but far inferior, and less elastic than *C. esculenta*. Measurements of the creepers have been made, which show the thickness of the stem at 5 to 7 years old to vary from 9 to 11 inches in circumference. Assuming the trees to be 30 feet apart, the followind details given by Mr. Strettel will enable us to form a fair idea of the probable financial results. Area to be cultvated, 400 acres; trees at 30 feet by 30 feet equal per acre 48, or 19,200 creepers on 400 acres. Minimum yield of caoutchouc per annum estimated at one viss (3lbs. 2oz.) per creeper, equal 19,200, or at £20 per 100 viss, £3,830 per annum. The cost of starting this project is trifling in the extreme. All that is necessary ought not to exceed on an average of seven years eight shillings per acre per annum. After the first year the creepers will have attained a sufficient height to require little or no further attention beyond, of course, protection from fire, &c. Thus at the end of seven years the cost on 400 acres would represent £1,120. At the expiration of seven years the expenses will embrace tapping, pressing, and preparing the caoutchouc, which are estimated at 12½ per cent. of the profit. According to these figures and the present market value of the india-rubber of this creeper, the net assets of the scheme may be approximated at £3,360 per annum. The milk of this creeper apparently more readily coagulates than that of the *Ficus elastica*. The lactiferous vessels are those that yield the inspissated milk, and when packing care should be taken not to cut into the sap wood. Mr. Strettel says: "The cut I adopt is in the form of an arrow, and the incisions are made on the sides of the stem. The tiers of arrows should be three feet apart, and so regulated that the cuts do not come in a perpendicular line with those below. At the point of the arrow I attach a funnel, formed of the leaves of the *Butea frondosa*, which readily attaches itself to the tree, from the glutinous nature of the milk. Any other leaves will answer equally well, if sufficiently large and proof against cracking. The season for tapping the trees is about the end of April. Between October and March circulation is slow and milk scarce, but during the rains the milk is more aqueous, and flows more readily. Chemical tests have proved that the rubber of *C. esculenta* is purer and better suited for most purposes than that obtained from the *Ficus elastica*. —*Journal of Applied Science*.